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For

ADVANCED STUDY INSTITUTE ON THE SCIENCE & TECHNOLOGY OF NANOSTRUCTURED MAGNETIC MATERIALS

Crete, Greece
June 25, 1990 to July 6, 1990

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Dr. Larry R. Cooper
Office of Naval Research
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Arlington, VA 22217-5000

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Prof. George C. Hadjipanayis
University of Delaware
Department of Physics and Astronomy
Newark, DE 19716-2570

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Office of Naval Research

6c. ADDRESS *(City, State, and ZIP Code)*
Department of Physics & Astronomy
223 Sharp Laboratory
Newark, DE 19716

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8b. OFFICE SYMBOL *(If applicable)*

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The Institute reviewed the remarkable progress made in magnetic materials over the last few years and addressed the current state-of-the-art research and its impact on technological applications. The subject matter fell into a number of broad areas including thin films, multilayers, disordered systems, ultrafine particles, intermetallic compounds, permanent magnets and magnetic imaging techniques.

The development of new techniques for materials preparation has made a dramatic impact in the area of epitaxial growth of magnetic films. Several presentations have shown that this process can be controlled on the scale of atomic layers permitting the growth of artificial structures such as artificial superlattices with nearly atomic resolution. Epitaxial growth has also permitted the stabilization of metastable phases in thin films which often possess a strong perpendicular anisotropy.

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which may prove useful for technological applications. In magnetic multilayers and superlattices the complex coupling between different magnetic layers was discussed both experimentally and theoretically. Magnetic surfaces and interfaces show large magnetic anisotropy (surface anisotropy), coercivity, magnetoresistance, galvanomagnetic and magnetooptic effects that can lead to future storage technologies. Several contributions discussed the physics of ultrafine particles and grandular solids with interesting and unique properties from superparamagnetism to strong magnetic hysteresis. The magnetic properties of rare-earth intermetallic compounds with potential applications in permanent magnets have been discussed including the crystal field effects and the origin of magnetic anisotropy. The magnetic hysteresis behavior of fine particles, permanent magnets, melt-spun ribbons and mechanically alloyed magnets have been discussed.

Finally the applications of magnetic materials in magnetic recording, magneto-optic recording and permanent magnets have been discussed with more emphasis given to the improvement of material properties for these applications.

CHAPTERS

June 25 - July 6, 1990
Heraklion (Aghia Pelayia) Crete, Greece

Dr. George C. Hadjipanayis
Dept. of Physics & Astronomy
University of Delaware, Newark, DE 19716

The Institute reviewed the remarkable progress made in magnetic materials over the last few years and addressed the current state-of-the-art research and its impact on technological applications. The subject matter fell into a number of broad areas including thin films, multilayers, disordered systems, ultrafine particles, intermetallic compounds, *permanent magnets and magnetic imaging techniques.*

The development of new techniques for materials preparation has made a dramatic impact in the area of epitaxial growth of magnetic films. Several presentations have shown that this process can be controlled on the scale of atomic layers permitting the growth of artificial structures such as artificial superlattices with nearly atomic resolution. Epitaxial growth has also permitted the stabilization of metastable phases in thin films which often possess a strong perpendicular anisotropy which may prove useful for technological applications. In magnetic multilayers and superlattices the complex coupling between different magnetic layers was discussed both experimentally and theoretically. In superlattices it was proposed that a strong coupling between two ferromagnetic layers can be carried out through an intervening layer which is not ferromagnetic. This coupling leads to new properties not seen in the past. Magnetic surfaces and interfaces show large magnetic anisotropy (surface anistropy), coercivity, magnetoresistance, galvanomagnetic and magnetooptic effects that can lead to future storage technologies. Band structure studies using statistical techniques of Monte Carlo calculations, led to accurate calculations of the Curie temperature of Fe, Co, Ni films. The solution of this problem opened the door for other important phenomena which are due to "spin orbit" coupling. Several contributions discussed the physics of ultrafine particles and granular solids with interesting and unique properties from superparamagnetism to strong magnetic hysteresis. The magnetic properties of rare-earth intermetallic compounds with potential applications in permanent magnets have been discussed including the crystal field effects and the origin of magnetic anisotropy. The magnetic hysteresis behavior of fine particles, permanent magnets, melt-spun ribbons and mechanically alloyed magnets have been discussed. The magnetic hysteresis models of "domain wall pinning" and "nucleation of reversed domains" have been reviewed and their applicability in different magnetic materials was discussed. The micromagnetic approach using the Landau-Lifshitz-Gilbert equation was also presented to explain the hysteresis behavior of thin films.

The magnetic properties of all of these materials are strongly influenced by their microstructure and several methods to evaluate their growth, lattice structure and sample integrity were discussed. These included spin-polarized electron spectroscopy, DPC and RHEED/RE Microscopy and Lorentz microscopy.

Finally the applications of magnetic materials in magnetic recording, magneto-optic recording and permanent magnets have been discussed with more emphasis given to the improvement of material properties for these applications.

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LECTURERS

Professor C. Chien
Johns Hopkins University
Department of Physics
Baltimore, MD 21218

Professor T. Coey
Department of Pure & Applied Physics
Trinity College
Dublin 2
IRELAND

Professor J. Cullen
Naval Surface Weapons Center
Silver Springs, MD 20901-5900

Professor W. deJong
Department of Physics
Eindhoven University of Technology
de Dolech 2
NL-5600 MB Eindhoven
NETHERLANDS

Professor A. Fert
Laboratoire de Physique des Solides
Universite Paris Sud
F91405 Orsay, FRANCE

Professor N. Garcia
Department of Physics
Autonouous University of Madrid
Madrid, SPAIN

Professor D. Givord
Neel Laboratory
CNRS 166X-38042
Grenoble, CEDEX
FRANCE

Professor G. Hadjipanayis
University of Delaware
Department of Physics & Astronomy
Newark, DE 19716

Professor H. Jansen
Department of Physics
Oregon State University
Corvallis, OR 97331

Professor J. Kirschner
Institut fur Grenzflachenforschung
and Vakuumphyisk
KFA Julich
WEST GERMANY

Professor K. Kronmuller
Max-Planck Inst. fur Metallforschung
Institut fur Physik
Heisenbergstrasse 1
7000 Stuttgard 80
WEST GERMANY

Professor A. Morrish
Department of Physics
University of Manitoba
Winnepeg, MAN R3T 2N2
CANADA

Dr. G. Prinz
Naval Research Laboratory
Washington, DC 20390

Professor J. Rhyne
National Bureau of Standards
Gaithersburg, MD 20899

Professor D. Sellmyer
Department of Physics
University of Nebraska
Lincoln, NE 68588

Professor J. Spence
Department of Physics
Arizona State University
Tempe, AZ 85287

SPEAKERS

Professor V. Amaral
Centro de Fisica de Universidade
de Porto
4000 Porto
PORTUGAL

Dr. P. Alexopoulos
IBM Almaden Research Center
650 Harry Road
San Jose, CA 95120-6099

Dr. S. Arajs
Department of Physics
Clarkson University
Potsdam, NY 13676

Dr. G. Asti
Institute MASPEC del C.N.R.
via Chiavari, 18 A, 43100 Parma
ITALY

Dr. N. Berker
MIT
Physics Department
Cambridge, MA 02139

Dr. A. Berkowitz
Mail Code R-001
Center for Magnetic Recording
Univeristy of CA - San Diego
La Jolla, CA 92093

Dr. R. Celotta
National Institute of Science
& Technology
Gaithersburg, MD 20899

Dr. Daalderop
Philips Research Lab
Eindhoven
THE NETHERLANDS

Dr. J. Dekoster
Celestunenlaan 200-D
B 3030, Leuven, BELGIUM

Dr. O. Donzelli
Dipartimento di Fisica
Universita (GNSM-CISM)
via Paradiso 12
44100 Ferrara
ITALY

Dr. E. Dulis
Crucible Research Inc.
Pittsburgh, PA 15212

Dr. C. Falco
Optical Science Center
& Physics Dept.
University of Arizona
Tucson, AZ 85721

Dr. J. Fidler
Technical Universitat Wien
Wiederer Hausptstrasse 8-10
A-104 Wien
AUSTRIA

Professor P.J.P. Freitas
INESC, rua Alves Redol 9
Apartado 10105
1017 Lisboa Codex
PORTUGAL

Dr. J. J. M. Franse
Natuurkunding Laboratorium
University of Amsterdam
Valckenierstraat 65
1018 XE Amsterdam
THE NETHERLANDS

Dr. R. J. Gambino
IBM
Thomas J. Watson Research
Yorktown Heights, NY 10598

Dr. J. Gavighan
Neel Laboratory
CNRS 166X-38042
Grenoble, CEDEX
FRANCE

Dr. B. Heinrich
Physics Department
Simon Fraser University
Burnaby, BC, CANADA

Dr. A. Hernando
Laboratoire de Magnetismo
Facultad de C Fisicas
University Completense
28040 Madrid, SPAIN

Dr. K. Howard
Department 72/028
IBM
5600 Cottle Road
San Jose, CA 95193

Dr. F. Humphrey
Boston University
P.O. Box 722
Meredith, NH 03253

Dr. H. Hurdequint
Laboratoire de Physique
des Solides
Universite Paris Sud
91405 Orsay
FRANCE

Mrs. T. H. Jacobs
Kamerlingh Onnes Lab
University of Leiden
2300 RA Leiden
THE NETHERLANDS

Dr. J. P. Jakubovics
Dept. of Metallurgy & Science
of Materials
University of Oxford
Parks Road, Oxford OX1 3PH
ENGLAND

Dr. N. Koon
Naval Research Lab
Washington, D.C. 20375

Dr. T. Kostikas
Demokritos National Research Center
Institute of Materials Science
153 10 Ag. Paraskeri Attikis
P.O.B. 60228
GREECE

Dr. F. Meier
Laboratorium Festkorperphysik
ETH Honggerberg
CH-08093 Zurich
SWITZERLAND

Dr. D. Mergel
Philips Research Lab
D-2000 Hamburg 54
POB 540840
GERMANY

Dr. S. Morup
Laboratory of Applied Physics
of Denmark
DK-2800 Lyngby
DENMARK

Dr. K.S.V.L. Narasimhan
Hoeganaes Magnetics
65 Indel Avenue
Rancocas, NJ 08073

Dr. R. O'Handley
MIT
77 Massachusetts Avenue
Cambridge, MA 02139

Dr. M. O'Shea
Department of Physics
Cardwell Hall
Kansas State University
Manhattan, KS 66506

Dr. M. Piecuch
Laboratoire Mixte
CNRS-Saint Gobain
CRPAM-BP 109
54704 Pont-A-Mousson CEDEX
FRANCE

Dr. F. E. Pinkerton
Physics Department
General Motors Research Labs
Warren, MI 48090-9055

Dr. J. Rivas
Depto. Fisica Applicada
Facultad de Fisica
E-15708 Santiago de Compostela
SPAIN

Dr. M. Rots
Instituut voor Kern-en Strakingsfyska
Katholieke Universiteit
Leuven, BELGIUM

Dr. L. Shultz
Siemens, AG Research Labs.
D-8520 Erlangen
FEDERAL REPUBLIC OF GERMANY

Professor K. V. Rao
Department of Solid State Physics
Royal Institute of Technology
Stockholm, SWEDEN

Dr. C. Soukoulis
Department of Physics
Iowa State University
Ames, IA 50010

Dr. J. Tejada
Facultad de Fisica
Universidad de Barcelona
Diagonal 647.08028
SPAIN

Professor T. Tsakalakos
Rutgers University
Department of Materials Science
P.O. Box 909
Piscataway, NJ 08854

Dr. R. H. Victora
Diversified Technologies Div.
Research Laboratories
Eastman Kodak Co.
Rochester, NY 14650

PARTICIPANTS

Professor V. Amaral
Centro de Fisica de Universidade de Porto
4000 Porto
PORTUGAL

Professor F. Badia
Dept. de Fisica Fonamental
Universitat de Barcelona
Diagonal 647
E-08028
SPAIN

Dr. T. Bakas
Univeristy of Ioannina
P.O.B. 1186
OR-451 10 Ioannina, GREECE

Mr. C. Ballentine
MIT, Rm. 4-015
Cambridge, MA 02139

Professor C. Beatrice
Instituto Elettrotecnico Nazionale
Galileo Ferraris
c.So D'Azeglio 42
10125 Torino
ITALY

Mr. P. Belien
University of Leuven
Department of Physics
Celestijnenlaan 200 D
B-3030 Leuven, BELGIUM

Mr. M. Carey
Center for Magnetic Recording Res.
Univ. of California, San Diego
La Jolla, CA 92093

Dr. Z. Celinski
Department of Physics
Simon Fraser University
Burnaby VSA IS6
BRITISH COLUMBIA

Mr. J. Childress
Johns Hopkins University
Department of Physics
Baltimore, MD 21218

Mr. C. Christides
Institute of Materials Science
DEMOKRITOS N.R.CPS
Ag. Paraskevi, Attiki, GREECE

Dr. A. Clark
Naval Surface Weapon Center
Silver Spring, MD 20903

Mr. J. Costa Kramer
Department of Solid State Physics
Royal Institute of Technology
S-10044, Stockholm, SWEDEN

Professor R. Day
Csiro Applied Physics
PO Box 218
Lindfield NSU 2070
AUSTRALIA

Mr. B. Engel
Department of Physics
University of Arizona
Tucson, ARIZONA 85721

Dr. J. Filippi
Laboratoire Louis Neel
C.N.R.S.
166X, 38042
Grenoble, CEDEX
FRANCE

Dr. N. Flevaris
Solid State Physics
Aristotelio University of Thesaloniki
54006, Thelolonikí
GREECE

Professor G. Fratucello
Universita di Ferrara
Departmento di Fisica
via Paradiso 1-44100
Ferrara, ITALY

Mr. A. Garvin
Department of Physics & Astronoy
Johns Hopkins University
Baltimore, MD 21218

Mr. J. Guzman
Magnetics Technology Center
Carnegie Mellon University
Pittsburgh, PA 15213

Mr. L. Giordano
Centro Atomico
8400-Bariloche
ARGENTINA

Dr. J. Gonzalez
Inst. de Ciencia de Materiales
C.S.I.C.
Serrano 144 28006
Madrid SPAIN

Professor M. Hammond
Freie Universitat Berlin
Fachbereich Physik
Institut fur Arom under
Festkorperphysik (WE-1)
Arnimallee 14, D-1000 Berlin
FEDERAL REPUBLIC OF GERMANY

Dr. M. Hanson
Physics Department
Chalmers University of Technology
S-412 96 Goteborg, SWEDEN

Dr. K. Hathaway
Code 1114
Office of Naval Research
800 N. Quincy Street
Arlington, VA 22217

Mr. P. Hendriksen
Lab. of Applied Physics
Tech. Univ. of Denmark
DK Lyngby, DENMARK

Mr. D. Hurley
Dept. of Pure & Applied Physics
Trinity College
Dublin 2, IRELAND

Professor R. Krishnan
Laboratoire de Magnetisme CNRS
92195 Meudon CEDEX
FRANCE

Dr. S. Linderoth
Lab. of Applied Physics
Technical University of Denmark
DK-2800, Lyngby
DENMARK

Dr. R. McCallum
Ames Lab, 106 Wilhelm Hall
Iowa State University
Ames, IA 50011

Dr. I. McFadyen
IBM Research Division
Almaden Research Center
650 Harry Road
San Jose, CA 95120-6099

Professor B. Martinez
Dept. de Fisica Fonamental
Universitat de Barcelona
Diagonal 647
E-08028 Barcelona
SPAIN

Ms. N. Karaoglu
Dakuz Eylul University
Engineering Architectural Faculty
Geological Engineering 35100
Bornova/Izmir, TURKEY

Mr. C. Koch
Lab. of Applied Physics
Bldg. 307
Tech. Univ. of Denmark
DK-2800 Lyngby, DENMARK

Ms. K. Mahoney
R43 Naval Surface Warfare Center
Silver Spring, MD 20905-5000

Professor C. Mavroyamnnis
Division of Chemistry
National Research Council of Canada
Ottawa, Ontario, Canada K1A OR6

Dr. L. Melo
INESC
R. Alves Redol, 9-3
P-1000 Lisboa, PORTUGAL

Dr. D. Niarchos
Demokritos National Research Center
153 10 Ag. Paraskeri Attikis
P.O.B. 60228
GREECE

Mr. J. Nogues
Department of Solid St. Physics
Royal Inst. of Tech.
S-100 44, Stockholm, SWEDEN

Dr. M. Olivieria
MIT-Department of Physics
77 Massachusetts Avenue
Cambridge, MA 02139

Dr. Y. Otani
Trinity College
Department of Pure & Applied Physics
Dublin 2, IRELAND

Dr. V. Papefthymiou
Demokritos National Research Center
Inst. of Materials Science
152-3 10 Ag. Paraskeri Attikis
P.O.B. 60228
GREECE

Dr. F. Petroff
Laboratoire de Physique des Solides
Univesite Paris-Sud
91405 Orsay
FRANCE

Dr. D. Polk
Materials Division
Office of Naval Research
800 N. Quincy Street
Arlington, VA 22217

Ms. M. Pont
Departamento de Fisica
Universitat Autonoma Barcelona
08193 Bellaterr SPAIN

Professor P. Poulopoulos
Department of Physics
Aristotle University of Thessaloniki
Thessaloniki, GREECE

Professor E. Ribas
Dept. de Fisica Fonamental
Universitat de Barcelona
Diagonal 647, E-08028 SPAIN
08028 Barcelona, SPAIN

Dr. J. Schmidt
Inst. de Fisica-UFRGS
Cx. Postal 15051
Porto Alegre, RS 91500 BRAZIL

Professor C. Schneider
Freeie Universitat Berlin
Fachbereich Physik
Institut fur Atom under
Festkorperphysik (WE 1)
Arminallee 14, D-1000
Berlin 33
FEDERAL REPUBLIC OF GERMANY

Dr. I. Shah
E. I. duPont Experimental Station
P.O. Box 80356
Wilmington, DE 19880-0356

Mr. Z. Shan
Dept. of Physics & Astronmy
Behlen Lab
Lincoln, NE 68588

Dr. B. Siberchicot
Boite Postale 27
94190-Villeneuve St. Georges
FRANCE

Dr. W. Simmons
Chief Materials Branch
U.S. Army Research
Development & Standardization Group
Edison House, 223 Old Marylebone Rd.
London NW11 5th
ENGLAND

Dr. T. Simopoulos
Demokritos National Research Center
Inst. of Materials Science
153 10 Ag. Paraskeri Attikis
P.O.B. 60228
GREECE

Mr. E. Singleton
University of Delaware
Dept. of Physics & Astronomy
223 Sharp Lab
Newark, DE 19716

Dr. S. Sinha
Physics Department
Brookhaven National Lab
Upton, NY 11973

Mr. S. Slade
University of California-San Diego
Center for Magnetic Recording
R-001
La Jolla, CA 92093

Dr. J. Slaughter
Department of Physics
Building 81
University of Arizona
Tucson, AZ 85721

Dr. M. Solzi
Instituto Materiali Speciali
Per Elettronica E. Magnetism
MASPEC
43100 Parma, ITALY

Professor J. Sousa
Centro de Fisica de Universidade de
Porto
4000 Porto
PORTUGAL

Professor C. Stassis
Iowa State University
Department of Physics
Ames, IA 50011

Dr. J. Teter
R43, Naval Surface Warfare Center
Silver Springs, MD 20905-5000

Dr. F. Tezer
Physics Department
Hacettepe University
Beytepe, Ankara
TURKEY 06532

Dr. I. Thomas
Department of Energy
19901 Germantown Road
Germantown, MD 20874

Ms. T. Tsoukatos
University of Delaware
Department of Physics and Astronomy
223 Sharp Laboratory
Newark, DE 19716

Dr. K. Unruh
University of Delaware
Dept. of Physics & Astronomy
223 Sharp Lab
Newark, DE 19716

Dr. C. Williams
Code 6346
U.S. Naval Research Laboratory
Washington, DC 20375-5000

Mr. G. Zouganelis
National Center for Scientific
Research "DEMOKRITOS"
Institute of Materials Science
153 10 Ag. Paraskevi Attikis
GREECE